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CONTENTS

	PAGE
Cockbill, G. F. Records of migrations of *Catopsilia florella* F. (Pieridae) from Southern Rhodesia, 1922–1950 . .	113–128, 4 figs.
Eastop, V. F. Diurnal variation in the aerial density of Aphididae . . .	129–134, 1 fig.
Henson, H., D.Sc., Ph.D., F.R.E.S. On the wings of *Forficula auricularia* Linn. (Dermaptera)	135–142, 2 figs.
Book Notices	128, 134
General Index	143

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RECORDS OF MIGRATIONS OF *CATOPSILIA FLORELLA* F. (PIERIDAE) FROM SOUTHERN RHODESIA, 1922–1950.

By G. F. Cockbill.

In his book (Williams, 1930) and again (Williams *et al.*, 1942) Dr. C. B. Williams refers to the scarcity of records from Southern Rhodesia of the migrations of *Catopsilia florella*. In the former he states, " The Rhodesian movements . . . are said to be more to the S., S.E., and S.W., but exact records are few," while in the latter publication he remarks, " In N. and S. Rhodesia there are practically no flights to the N. and N.W.," and further, " more records are needed from all areas . . ."

Since joining the staff of the Division of Entomology, Department of Agriculture and Lands, Southern Rhodesia, the writer has had access to the departmental journals in which were found migration records going back to 1922. These records have been compiled by members of staff, in particular by Messrs. R. W. Jack, M. C. Mossop, A. Cuthbertson, E. C. G. Pinhey, and, since September, 1949, by the writer. They are published here verbatim, except that they have been edited slightly to conform with the arrangement adopted by Williams (*loc. cit.*).

I am grateful to Mr. M. C. Mossop, Chief Entomologist, Department of Agriculture and Lands, Southern Rhodesia, for his suggestion that these records be gathered together and made available in the literature.

1. The Records of *Catopsilia florella* in Southern Rhodesia, 1922–1950.

The following are the records of *C. florella* in Southern Rhodesia from 1922 to 1950 :

1922, Dec. 28. **Umvuma.** **To S.**
The flight was reported about this date. R. W. Jack. 5.1.23

1923, Jan. 1. **Salisbury.** **To S.W.**
The flight has continued with varying intensity daily until nightfall to-day ; weather mostly broken ; same direction. R. W. Jack.

1923, Jan. 1. **Balla Balla.** **To S.W.**
Butterflies were passing farm, 5 miles south of Balla Balla, for 7 or 8 days about New Year. C. Boggie.

1923, Jan., 2nd week. **Selukwe.** **To S.W.**
Swarm crossing camp for 5 days travelling S.W. and across the wind rather than with it. J. L. Heward. 17.1.23.

1923, Jan. 15. **Manyami.** **To S.W.**
Passing over slowly for several days—thinly scattered. R. MacNeilage.

1923, Jan. **Melsetter.** **Due S.**
Butterflies first seen in central position of Melsetter district, west of Melsetter town, continued for about 14 days. T. O. Willows. 25.1.23.

1923, Jan. 19. **Banket.** **To S.W.**
Large quantities flying S.W. on two consecutive days. Farm is west of Umvukwes, about 40 miles from Banket. Not observed at Sipolilo. E. Ainslie.

1923, Jan. 23. **Mt. Darwin.** **To S.**
Butterflies came over Darwin flying north to south. T. V. Wessel.

1923, Jan. 24. **N. of Sinoia.** **To S.S.W.**
In thousands. Unusual number of hawk moths around lamp at night also noted, as above same time. Farm situated 36–38 miles N. of Sinoia. H. Drayton.

1923, Jan. 24. **Felixburg.** —
Butterflies have been general from this farm to Enkeldoorn. J. H. Levason.

1923, Feb. 2. **Salisbury.** —
No definite flight to-day ; wind fresh from E. 12.15 : Thin flight still passing. R. W. Jack.

1926, Dec., end. **Marandellas.** —
In 1926 migration of these butterflies lasted 2 days only C. D. Priest. 8.1.29.

1927, Jan. **Sinoia.** **To S.W.**
Flights noted on a prevailing N.E. wind. J. H. Parkinson.

1927, Dec. 26. **Salisbury.** **To W.S.W.**
On granite veld S.E. of Salisbury a flight of this species passing S. or W. through the trees of moderately dense savannah forest, quite numerous at times ; may be mixed *gidica* and *mesentina* but difficult to see ; appeared to be a few yellow ♂s occasionally, but could not catch for certain determination. Weather mild and inclined to showers. R. W. Jack.

1927, Dec., end. **Marandellas.** —
In 1927 migration of these butterflies lasted 3 days only. C. D. Priest.

1928, Jan. 4. **Salisbury.** **To W.S.W.**
Thin flight still continues in same direction through Salisbury but very thin. R. W. Jack.

1928, Jan. **Sinoia.** **To S.W.**
Flights noted on a prevailing N.E. wind. J. H. Parkinson.

1928, Dec. 14–1929, Jan. 19. **Eldorado.** **To S.S.W.**
First noticed here this year on 14th Dec., 1928, direction from 30° E. of N. Continued in more or less constant numbers until 9th Jan., 1929—when the wind changed and met them directly and I noticed very few. They did not cease till about 10 days (19th about), but exact day unknown. G. H. Cautherley.

1928, Dec., mid. **Salisbury.** **To S.W.**
Migrations in last 3 weeks always S.W. M. Webb. 9.1.29.

1928, Dec. 26–1929, Jan. 4. **Salisbury.** **To S.**
Noticed daily from 26th Dec., 1928, swarms of white butterflies flying from N. to S. in western commonage, pass here from 11 a.m. till 2 p.m. ; small percentage have black tips on their wings. W. E. Taylor.

1928, Dec. 27–1929, Jan. 5. **Gatooma.** **To S.**
First noticed in large numbers on 27th Dec. all flying due south. Since then smaller numbers have continued to fly past in same direction. Henderson.

1928, Dec. (Christmas) on. **Inyazura.** **To S.E.**
Passing here since Xmas up to 10th Jan. in direction of Umtali. H. A. Long. 10.1.29.

1928, Dec., end. **Salisbury.** **To S.W.**
Migration has been going on for well over a week and the last 2 days have noticed a fair sprinkling of a pale yellow *rhadia* form of ♀, *teste* R. W. J., always flying in a S.W. direction. C. J. Gibbs.

1928, Dec. 30–1929, Jan. 8. **Marandellas.** **To S.**
In 1928 they (common white) commenced on 30th Dec. and passed given point at about 10 individuals per minute—increased to 20th ; on 1st " countless hordes " passed = 100 per cent. To-day the percentage dropped to 25 per cent.—about rate of 30th Dec. Many other species are now showing—deep chestnut brown (*Atella phalanta*) which, although not conspicuous, has reached 25 per cent. Noticed also black and yellow (which likes orange blossoms) and a quantity of Brimstones. Travelling N. to S. Prevailing wind E. to S.E. no influence on flight . . . and flight extending for 10 miles. Time of flight about 8 a.m. till 4.30 p.m. Locality—50 miles S. of Marandellas Stn., 7 m. N.W. Wedza Mine, 7 m. S.W. from Wedza Police Camp. C. D. Priest 8.1.29.

1928, Dec. 31–1929, Jan. 4. **Que Que.** **To S.**
White butterflies in large numbers have been passing for the last 5 days almost due N. to S. Davey.

1928, Dec., end–1929, Jan. 5. **Salisbury.** **To S.**
Noticed for the last week a continual flight of butterflies—including White, Brimstone and Fritillary—direction from Mazoe to South. Var. *rhadia* also seen = " brimstone." G. C. Hobson.

1929, Jan. 1–3. **Makwiro.** **To W.S.W.**
Have noticed for about 3 days a lot of white butterflies which seem to be going W.S.W. F. H. Howard.

1928, Dec., end–1929, Jan. 5. **Makwiro.** **To W.S.W.**
During the greater part of this week these (white) butterflies have been travelling in a W.S.W. direction, but between 12 noon and 2 p.m. on Wed., 2nd Jan. . . . . on my way to and from Makwiro just off this farm . . . a cloud of them travelling on a compass bearing of approx. 250°. J. Donaldson.

1929, Jan. 1. **Salisbury.** **To S.W.**
Twenty-five miles along Darwendale road but none after that up to 33 miles, flying S.W. across Salisbury. F. T. Wigg.

1929, Jan. 1. **Nyabira.** **To N.W. and S.**
At Borrowdale to N.W. carried by wind but to S. without wind. At Nyabira came over in swarms. Rev. T. C. B. Vlok.

1929, Jan. 1–4. **Salisbury.** **To S.W.**
Noted flight which lasted 4 days, max. flight height 10 ft., rate 8 m.p.h. ; *rhadia* form about 1 in 50. None ever alighted. G. T. Bennett.

1929, Jan. 1–21. **Gatooma.** **To S.W.**
Beginning at 11 a.m. and continuing till about 4 p.m. each day. D. S. I. Davies.

1929, Jan., 1st week. **Mazoe.** **To S.S.W.**
First week in January in sheltered place at 60 per minute from N.N.E. to S.S.W. lasted at least 2 days. H. B. Douglas.

1929, Jan., 1st week. **M'sonneddi.** **To S.W.**
In large numbers. H. K. Tracewell.

1929, Jan. 2. **Nyabira.** **Due S.**
R. W. Jack.

1929, Jan. 2, 4, 5. **Trelawney.** **To S.E.**
Seen between 10 and 11 a.m. H. D. de Pree.

1929, Jan. 2. **Salisbury.** **To S.W.**
Brisk flight about 11 a.m. accompanied by occasional bunches of a brown species—unable to secure specimens. R. W. Jack.

1929, Jan. 2–4. **Eldorado (Sinoia).** **To S.W.**
Noticed on farm white butterflies 2nd, 3rd and 4th Jan., flying fast in a continuous stream, taking no notice of one another and never settling. Weather 2nd showery, 3rd overcast, and 4th hot and cloudless. On 5th a few stragglers in the morning but none after about 10 a.m. C. E. Crane.

1929, Jan. 3. **Marandellas.** **To S.**
Large swarm seen. J. H. Finch.

1929, Jan. 3 and 4. **Eiffel Flats (Gatooma).** **To S.**
Large numbers of white butterflies started to pass here about mid-day on 3rd; small numbers were still passing at 3 p.m. on 4th. W. B. Blyth.

1929, Jan. 3–5. **Sinoia.** **To S.W.**
During the afternoons crowds of white butterflies seen flying past the Sinoia school. W. Gebbie.

1929, Jan. 3 and 4. **Salisbury.** **To S.W.**
Thousands. Mrs. Walton.

1929, Jan. 3 and 4. **Que Que.** **To S.S.E.**
Large flights passed here 3rd Jan. and 4th in smaller numbers. To-day wind from S.E. arisen—no sign of white butterflies. Fowler.

1929, Jan. 4–6. **Umtali.** **To S.W. and S.**
Looking over the groves from the homestead as many as 6–12 could be counted at one time, but in the open fields they appeared more numerous. At no time was there a break in their flight; they were very scattered. W. H. Perrott.

1929, Jan. 3–6. **Que Que.** **To S.S.W.**
Butterflies passing at rate of hundreds per minute—white species with a few brown on 3rd, 4th, few 5th and 6th. Not so great a migration as in 1926. H. A. Hutchinson.

1929, Jan. **Salisbury.** **To S.W.**
Flights of this species have continued day by day and have been noted at least as far abroad as Govt. Farm, Gwebi. They have continued usually from about 9 a.m. to 5 p.m. I have seen odd yellow butterflies amongst the flight which look like the yellow form of this species. A Nymphalid has also commonly been associated in some numbers = *Atella phalantha*. R. W. Jack.

1929, Jan. 5. **Trelawney.** **To W.**
Seen at 11.30 a.m. about half-way to Banket (6 miles). Still flying at 1 p.m. same day though in smaller numbers. G. W. Bird.

1929, Jan. 5. **Salisbury.** **To S.W.**
Flight continues through Salisbury. R. W. Jack.

1929, Jan. 5. **Gadzema (Hartley).** **To S.**
Especially noticeable on 5th as they are in an endless procession travelling rather fast . . . passing over in thousands. W. M. Wittingham.

1929, Jan., 1st week. **S. Marandellas.** **To S.S.E.**
During sunny spells large numbers. During the last few days they have been joined by a yellow variety resembling the English Clouded Yellow, and a common rich brown which one always sees round here. M. C. Myers.

1929, Jan. 7. **Norton.** **To S.**
At 12.30 a.m. white butterflies in a thin scattered flight lasting about one hour. Miss E. M. Downes.

1929, Jan. 7–17. **Salisbury.** **To S.**
The flight continued for about 10 days, excluding one day which was very cold and typical mvumbi weather. M. W. Greenhow.

1929, Jan. 8. **Plumtree.** **To S.**
According to Major Goad between Marula and Sundown Plumtree a flight was observed. W. W. Scott.

1929, Jan. 11. **Umtali.** **To S.W. and S.**
On 11th butterflies were much more numerous than on the dates mentioned in my letter of the 9th, flying in same direction. W. H. Perrott.

1929, Jan. 11. **Amandas.** **To S.W.**
White butterfly on 11th Jan., 2 in S.W. direction, 30° W. of S. Lo. 31°, Lat. 17° 34′.
C. Robertson.

1929, Jan. 12. **Odzi.** **To S.W.**
Flight from 10 a.m. till 4.30 p.m. passed on 12th.
Buchanan.

1929, Dec. 18. **Sinoia.** —
A flight commenced 10.30 a.m. and lasted two hours. Strong breeze from the north-west.
J. H. Parkinson.

1929, Dec. 18. **Gatooma.** **To S.**
L. Henderson.

1929, Dec. 24. **Salisbury.** **To S.W.**
Thin flight at 9 a.m.
R. W. Jack.

1929, Dec. 25–27 and 30. **Salisbury.** **To S.S.W.**
Thin flight continuing.
R. W. Jack.

1930, approx. Dec. 12–16. **Salisbury.** **To S.S.W.**
A thin flight proceeding through Salisbury—have noted tendency to south migration, not very decided, for several days past. The butterflies have been thickly about blue salvia flowers at the Agric. Lab. all day and are still lingering in large numbers 4 p.m.
R. W. Jack.

1930, Dec. 17–27. **Salisbury.** **To S.S.E. or S.S.W.**
Flights very thin.
R. W. Jack. 27.12.30.

1931, Nov. last week–Dec. 3. **Salisbury.** **To S.W.**
Flights very much thinner than usual (3.12.31). Last year late in the wet season I noted that individuals seemed to be making their way N.E. and, although there was no comparison with the steady S.W. flight earlier, the impression was that the N.E. direction was the rule.
R. W. Jack.

1931, Dec. 10. **Salisbury.** **To S.W.**
Still proceeding more frequent, but still thin.
R. W. Jack.

1931, Dec. 21. **Felixburg.** —
Passing in myriads.
J. H. Levason.

1933, approx. Dec. 4–8. **Salisbury.** **To S.S.W**
A very thin flight—fine weather after wet spell, 6 males captured.
R. W. Jack. 8.12.33.

1933, Dec., end–1934, Jan. 18. **Urungwe.** **To S.**
For the last three weeks hundreds have been going past here daily.
Asst. Native Commissioner.

1934, Jan. 13 and 20. **Salisbury.** **To S. and S.W.**
10–12 a.m.—a very thin flight.

1934, Feb., end–Mar. 10. **Salisbury.** **To. N.E.**
Flying in a comparatively thin stream, but some days thicker than others. Various species represented, mainly *B. gidica westwoodi*, but during past week *C. florella* prominent including many *rhadia* ♀s.
R. W. Jack. 10.3.34.

1934, Mar. 7–9. **Gatooma.** **To E.**
Large number for 3 days.
Houston (Williams, 1941).

1934, Mar. 23. **Salisbury.** **To N.E.**
C. florella still flying N.E.; many *rhadia* ♀s.
R. W. Jack.

1934, Mar. 24–Apr. 3. **Salisbury.** **To N.–N.E.**
Flight thin but persistent.
R. W. Jack.

1934, Nov. 20–Dec. 4. **Salisbury and Mazoe.** **To N.E.**
Single individuals passing at frequent intervals—all movement has appeared to be in the same direction as far as this species is concerned. Same day Dr. W. J. Hall of Mazoe Citrus Estate said he had noticed the same movement. R. W. Jack. 4.12.34.

1934, Dec. 21. **Salisbury.** **To S.W.**
Frequent individuals.

1934, Dec. 24. **Salisbury.** **To S.W.**
Two other species, at least, included—*B. gidica* and *A. phalantha ?* R. W. Jack.

1934, Dec. 28. **Salisbury.** **To S.W.**
Have been flying briskly in meantime—bunches at times; strong admixture of *? B. gidica.* R. W. Jack.

1935, Dec. 26–29. **Gatooma.** **To S.E.**
All day against E. and S.E. wind. Peat (Williams, 1941).

1936, Nov. 13. **Gatooma.** **To W.**
Widely spaced all day. Houston (Williams, 1941).

1936, Nov. 28. **Salisbury.** **To N.–N.E.**
Few yellow forms of *Catopsilia florella.* Sparse numbers. R. W. Jack.

1936, Dec. 22–Jan. 6, 1937. **Umsweswe.** **To S.E.**
Hundreds. Houston (Williams, 1941).

1937, Dec. 16–31. **Salisbury.** **To S.W.**
Almost daily from about 9.30 or 10. R. W. Jack.

1938, Jan. 1–7. **Salisbury.** **To S.W.**
A few *A. phalantha* also. R. W. Jack.

1938, Jan. 8–17. **Salisbury.** **To S.W.**
Flying almost daily (except during rain). R. W. Jack.

1938, Jan. 8. **Umtali–Salisbury.** —
Visitor (11.1.38) reported that he saw " myriads of white butterflies and some brown ones " all the way from Umtali on 8.1.38 to Salisbury, by car. R. W. Jack.

1938, Jan. 17. **Stapleford Forest Reserve.** **To S.**

1939, Apr. 26. **Salisbury.** **To N.E.**
Small numbers continued till end of month. Cuthbertson (Williams, 1941).

1940, Nov. 25. **Salisbury.** **To S.–S.W.**

1940, Nov. 30. **Salisbury.** **To S.W.**

1940, Dec. 1. **Salisbury.** **To. S.W.**
Few seen only.

1940, Dec. 7. **Salisbury.** **To S.W.**
Strong, numerous flight begun about 7.30 a.m. continuing until 5.45. p.m.; some *Atella phalantha* seen, and (?) yellow forms of *Catopsilia.*

1940, Dec. 8. **Salisbury.** **To S.W.**
Two specimens taken by native.

1940, Dec. 8–9. **Salisbury.** **To S.W.**
The migrations still going on, beginning each day from 7.30 to 8 a.m. On 8th about 10,000 were passing over 200-yard front per hour; counted over 2 or 3 individual minutes (approx.). Wind from east. M. C. Mossop.

1940, Dec. 9–13. **Salisbury.** **To S.W.**
Still proceeding, but numbers vary from day to day and time to time. At Highlands on 12th Dec., 1940, noted many *Catopsilia* feeding at Tree Forget-me-not (*Duranta plumieri*). A. Cuthbertson.

1941, Feb. 5–10, 15 and 16. Bulawayo. To N.E.

Catopsilia florella : Return migration ; Matopos, Bulawayo, sparse numbers of *Catopsilia* and *Belenois mesentina* during the hot part of the day from about 9 or 10 a.m., not moving fast ; observed feeding at flowers (Compositae).

1941, Feb. 22. Salisbury. To N.E.

Sparse numbers, 37–100 passing 50 yds. front in a minute.

1941, Mar. 9–12. Salisbury. To N.E.

Sparse numbers observed on 9th–12th March from about 10.30 a.m. until 2 p.m. ; few yellow forms noted.

Later : " Trickling back " of the butterflies noted above observed until the 16th April, 1941, being seen chiefly from 1–2 p.m. on warm sunny days at Avondale, but in small numbers only.

1941, Nov. 12 approx.–15. Salisbury. To E. and N.E.

C. florella and a few *Atella phalantha* have been flying to the E. and N.E., the opposite direction from the usual November direction. In density the numbers are about normal. The wind has been light, mainly from the north.

1941, Nov. 17. Salisbury. To N.E.

Counts over estimated 100-yd. front, per minute, at 1 p.m. were : 30, 12, 13.

M. C. Mossop.

1941, Nov. 18. Salisbury. To N.E.

Counts to nearest whole number over 100-yd. front in 1 minute with 10 to 30 seconds between counts, flying N.E. 9 a.m., were : 16, 14, 14, 16, 17, 32, 11, 16 ; av. 17 per min.

Twelve consecutive counts, one minute each, just after the above on 100-yd. front were : 18, 8, 17, 8, 11, 14, 18, 14, 19, 14, 16, 14 = av. 14 per min. ; or total 171 in 12 consecutive minutes averaging 855 per hour.

My experience is that this *rate of flight* is normal when the butterflies are flying at this time of year (direction reversed to date this season). In the figure 32, above, 20 passed in the first half-minute. Spurts such as these often occur, possibly being due to disturbances of those that are feeding, by change of light, wind, or other causes. M. C. Mossop.

1941, Nov. 19. Salisbury. To N.E.

8.40 a.m. : Five consecutive counts of 1 minute each as on 18th on 100-yd. front were 8, 19, 12, 14, 17 = av. 14 per min. or total 70 in 5 consecutive minutes or 840 per hour.

M. C. Mossop.

1941, Nov. 20. Salisbury. —

Overcast and windy, butterflies not evident.

1941, Nov. 22. Salisbury. To N.E.

10.15 a.m. : Six consecutive counts as above : 7, 5, 6, 5, 2, 5 = av. 5 per minute or total 30 in 6 consecutive minutes or 300 per hour. M. C. Mossop.

1941, Nov. 29. Salisbury. To S.W.

Since 22nd numbers continued to decrease for few days, and the *direction changed to more or less S.W.*, the normal direction for the November migration (see 15.11.41). Their direction may be a little more S. than usual. By to-day numbers have increased to, say, 800 per hour, *not* counted. The species were the same as before. M. C. Mossop.

1941, Dec. 14. Salisbury. To S.W.

Migration has continued, with diminishing numbers, but to-day there were very large numbers for a few minutes in sunshine immediately west of an approaching storm, from which the wind was blowing strongly. M. C. Mossop.

No notes taken 1942 and 1943.

1944, Dec. 16. Salisbury. To S.S.W.

Large migration of butterflies seen flying down Rotten Row at 1.30 p.m. Probably at rate of about 60 per minute or more, but I was unable to watch for more than a few minutes. E. C. G. Pinhey.

1946, approx. mid March. **Umtali.** **To N.**
Swarms over a width of 13 miles for 2 weeks. The direction taken is from south to north (previously it had occurred, on a much smaller scale, from west to east) . . .
Hon. Lionel Cripps
(per "Cabbages and Kings," *Rhod. Herald*, 5.4.46).

1946, Dec. 17. **Salisbury.** **To W.S.W.**
Prevailing wind from east, about 30–80 per minute, at Salisbury Experimental Station, 9 a.m. E. C. G. Pinhey.

1947, Dec. 6–7. **Salisbury.** **To W.S.W.**
At midday on 7th too many to count on 20-yd. front. B. P. Williams.

1947, Dec. 12. **Odzi to Salisbury.** —
Migration along the road from Odzi to Salisbury (150 miles by road). R. A. Jubb.

1947, Dec. 13. **Salisbury.** **To W.S.W.**
Experimental Station, Salisbury, Migration of Pierids at about 12.15 p.m. The flight was unusually dense and continuous and as far as one could see across the Experimental Station to Avondale and to Alexandra Park, also south of the main buildings ; after about 10–15 minutes of this dense flight it slackened off to the more general number of perhaps 10–15 per minute. All specimens seen were *Catopsilia florella*, except a few *Phalantha phalantha* (♂s). (On previous day a swarm had also been reported from Salisbury of "Yellow butterflies," but probably ♂s and ♀s of *C. florella* again ; other reports of dense flights of Whites on 12th in most parts of Salisbury.) Still continuing at 4 p.m.

1947, Dec. 14. **Salisbury.** —
Migration still in evidence all around Salisbury for more than 17 miles (where I turned off the Marandellas road) and up to Goromonzi (25 miles by road).

1947, Dec. 15. **Salisbury to 22 miles along Sinoia road.** —
Migration thinner, from Salisbury to 22 miles along Sinoia road, but no further.
J. Whellan.

1947, Dec. 15. **Salisbury.** —
No definite migration seen on Monday, 15th Dec. E. C. G. Pinhey.

Summary.
Migration appears to have been unusually dense and extensive over the period 12th–14th Dec., 1947, and reached at least from Salisbury to Odzi. E. C. G. Pinhey.

1947, Dec. 22 end. **Salisbury.** **To W.S.W.**
Another flight, almost as large as the one a few days earlier, at 2–2.30 p.m., fairly thick and extensive. Still continuing on 23rd Dec., and apparently till the end of that month.

1948, Jan., mid. **Salisbury.** **To E.N.E.**
Return flight. Slight migration back again about the middle of January.

1948, Nov., mid.–Dec., end. **Salisbury.** **To S.W.**
Catopsilia florella seen in small numbers until mid-December, when flight became of normal proportions. Continued until Christmas and then became a small trickle, not always definite about direction.

OBSERVATIONS MADE BY THE AUTHOR in 1949–50, ALL AT THE EXPERIMENTAL FARM, SALISBURY, UNLESS OTHERWISE STATED.

1949, Dec. 5.—9.10–9.15 a.m. in bright sun, after ·73 in. of rain on previous day. A thin migration was first noticed. 19 passed to N.E. in 5 mins. over 120-yard front flying in "waves" of 3 or 4 at about 11 m.p.h. (speed 80 yards in 15 secs., average 10·9 m.p.h.) 2–20 ft above ground. No wind. Heavy rain during day prevented further observations.

1949, Dec. 6.—10.00–10.05 a.m. : 18 passed to N. and N.E. in 5 mins. over 120-yd. front. 2 caught for identification. Wind from E.

1949, Dec. 7.—9.10–9.15 a.m. in bright sunshine : 14 passed in 5 mins. over 120-yd. front, flying to N. and N.E. Wind slight from E. 9.15–9.20 a.m. a few clouds passed : 6 seen flying to N. and N.E. in 5 mins. over 120-yd. front.

1949, Dec. 8.—9.42–9.47 a.m.: 1 flying to N.E., 4 to N. and N.W. 9.56–10.1 am.: 6 flying to N.W. (120 yd.).

1949, Dec. 9.—9.07–9.12 a.m.: Bright sunshine. No butterflies. Only 3 seen during the morning.

1949, Dec. 10.—9.40–9.45 a.m.: Bright sunshine. One only seen. 9.50: One seen flying to N.W.

1949, Dec. 12.—10.30–10.35 a.m.: Slightly overcast. No butterflies. 2 seen during the morning. Wind from N.

1949, Dec. 13.—10.20–10.25 a.m.: Dull, rain imminent. Slight wind from E. No butterflies seen.

1949, Dec. 14–16.—Weather dull. No observations made.

1949, Dec. 17.—9.35–9.40 a.m.: Bright sun. Wind from E. 1 seen flying to N., 2 to S.S.E. on 120-yd. front.

1949, Dec. 19.—9.12–9.17 a.m.: Bright sun. None seen. Wind from N. and N.W.

1949, Dec. 20.—10.15–10.20 a.m.: Sunny, some cloud. Wind from N.N.W. 6 seen flying to S.S.E. over 120-yd front. 10.25–10.30: 9 flying to S.S.E., 1 to S.E. over 120-yd. front.

1949, Dec. 21.—Sky overcast. 9.38–9.43: None seen.

1949, Dec. 23.—9.5–9.10: Bright sun. Very slight wind. 17 flying to S.S.E. over 120-yd front in 5 min.

1949, Dec. 24.—Lomagundi Road, Avondale, Sby. 1.30–1.32 p.m.: 24 *C. florella* passed over 60-yd. front to S.W. in 2 mins. Bright sun.

1949, Dec. 25.—Lomagundi Road, Avondale, Sby. 10.30 a.m.: 17 passed over 25-yd. front in 1 min. flying to S.W. Marlborough, Sby. 11.30 a.m.: 97 passed over 100 yds in 1 min. to S.W. Umvuma, S.R., noticed flying thickly to S.W.—de Klerk.

1949, Dec. 26.—Marlborough, Sby. 11.10 a.m.: 56 passed to S.W. in 1 min. over 100-yd front.

1949, Dec. 27.—Marlborough, Sby. 9.20 a.m.: 9 passed to S.W. in 1 min. over 100 yd. front. Wind was from N.E. 12.25 p.m.: 37 passed to S.W. over 100 yds. in 1 min.

1949, Dec. 28.—Wind from S.E. 46 passed to S.W. in 1 min. over 120-yd front.

1949, December 28 and 29.—"On 28th and 29th December from Bulawayo to Salisbury we were continually crossed by swarms of white butterflies, all flying East to West. Now they have arrived at Marandellas and are flying over this farm to-day. My son has just returned from Inyanga, and he noticed the same phenomenon there a week ago. . . ." Letter 1422/1/1 dated 3rd. Jan., 1950, from Mrs. J. Needham.

1949, Dec. 29.—Exp. Farm. Gwebi, nr. Sby. Migration still going to S.W. but intermittently because of heavy rain showers. 3 caught, and 1 *Glycestha aurota.*

1949, Dec. 30.—8.40 a.m.: Bright sun. Wind from E. 52 *C. florella*, 7 *Phalantha phalantha* and 3 *Precis cerebrene* passed to S.W. in 1 min. over 40 yds., the two latter species flying in groups of 3 or 4.

1949, Dec. 30.—Migration exceptionally dense from 25th to 30th Dec. 8.45 a.m.: Seven counts corrected to 100 yards (from 80 yards) taken over 1 to 2 minutes but reduced to 1 minute with intervals of a minute or so. To S.W.: 39, 40, 35, 33, 81, 47, 49. Average 46 per min. or 2940 per hour. Species present *C. florella, P. phalantha, P. cerebrene, Pinacopteryx eriphia, G. aurota, Colias electo.*

1949, Dec. 31.—Marlborough, Sby. 2.30 p.m.: 74 *C. florella* passed to S.W. in 1 min. over 100 yds. *P. phalantha* and *P. cerebrene* moving to S.W. also.

1950, Jan. 1.—Marlborough, Sby. 10.00 a.m.: 93 passed to S.W. in 1 min. over 100 yds.

1950, Jan. 3.—9.50 a.m.: 8 *C. florella* passed to S.W. in 1 min. over 40 yds., also 4 *P. phalantha* and 1 *P. cerebrene.* 10.15 a.m.: 56 (1 yellow ♀) passed to S.W. in 1 min. over 40 yds., also 4 *P. phalantha.*

1950, Jan. 4.—2.15 p.m.: Bright sun. 94 passed to S.W. over 80 yds. in 1 min. (2 yellow ♀s).

1950, Jan. 4.—Bedfordshire, P.O. Gwelo. "Over the past 10 days almost incessant swarms of white butterflies have been flying over this farm in a westerly direction. An occasional yellow and black butterfly was observed amongst them.—W. J. Till."

1950, Jan. 5.—3.30 p.m.: Bright sun. 9 passed over 40 yds. in 1 min. to S.W. (1 yellow ♀).

1950, Jan. 6.—10.30 a.m.: 97 passed over 40 yds. in 1 min. to S.W. and 6 *P. phalantha.* 10.50 a.m.: 21 *P. phalantha* passed to S.W. over 40-yd. front in 1 min.

1950, Jan. 7.—Telegram from Mrs. H. D. Gamble: "During past ten days through Mrewa Mtoka Makaha area have seen large swarms in constant stream of yellow and white butterflies mostly heading North" [*sic*].

1950, Jan. 7.—Marlborough, Sby., 2.30 p.m.: 23 (1 yellow ♀) in 1 min. over 100-yd. front to S.W. 3.55 p.m.: 119 (3 yellow ♀s) in 1 min. over 100-yd. front to S.W. Exp. Farm, Sby., 10.35 a.m.: 107 in 1 min. passed over 80-yd front to S.W. (5 yellow ♀s) also *P. phalantha* and *P. cerebrene.*

1950, Jan. 9.—9.15 a.m. after 2·2 in. rain on 8th Jan.: 9 passed over 40 yd. front in 1 min. to S.W. 10.10 a.m.: 29 passed in 1 min. over 80 yds. to S.W.

1950, Jan. 10.—Manica Road, Sby., 11.10 a.m.: 21 *P. cerebrene* passed in 1 min. over 3-yd. front to S.W.

1950, Jan. 13.—12.25 p.m.: 27 over 40-yd front passed to S.W. in 1 min. including yellow females. *P. phalantha, P. cerebrene* still moving. Previous days, 11th and 12th Jan., sky overcast.

1950, Jan. 17.—12.10 p.m.: 7 over 80-yd. front, passed to S.W. in 2 mins. A few seen loitering over maize plots. Directional movement is less strong.

1950, Jan. 18.—11.30–11.35 over 80-yd front: 12 *C. florella* and 3 *P. cerebrene* passed to S.W. in 5 mins. Sky with cloudy patches.

1950. Jan. 19.—2.20–2.25 p.m.: None passed over 80-yd. front in 5 mins. Occasional *C. florella* seen flying to S.W. during the day together with *P. phalantha.*

1950, Jan. 29.—Marlborough, Sby. 3 *C. florella* seen flying directly to S.W. together. 2.45 p.m.: These days *C. florella* are seen occasionally feeding at flowers, but showing no evidence of migration.

2. THE SEASONAL FLIGHTS OF *C. florella.*

Fig. 1 indicates the first and last records of each of the seasonal flights of this species. Their duration is indicated by a continuous line. The presence of a broken line indicates that a precise date has not been given, e.g., "1922, Dec., 2nd week," and "1927, January." The flights are designated here north or south, indicating that the recorded flight direction has a northerly or southerly component.

In Southern Rhodesia the rainy season usually extends from November to April, which is also the period over which flights of this species have been recorded.

Fig. 2 shows the flight directions marked on the map of Southern Rhodesia. As would be expected, the observations also indicate the areas with the largest white population, with Salisbury predominant. However, the flights have been recorded from widely separated parts of the Colony.

(a) *The Main Flight to the South.*

It is evident that the predominant and most constant flight takes place to the south during December and January. It has been recorded in 19 of the 29 years over which these observations extend. The average earliest date is 13th Dec. and the average flight period is 24 days. This figure is likely to be an underestimate, since first appearances of migrants are more often recorded than last appearances. The actual flight directions recorded are shown in fig. 3. Again the predominance of the southerly flight during December and January is shown. Actually, the main flight directions are to the south-west and south, but flights to the S.E., S.S.E. and W.S.W. have occurred. The southerly flight may begin as early as mid-November and may continue in

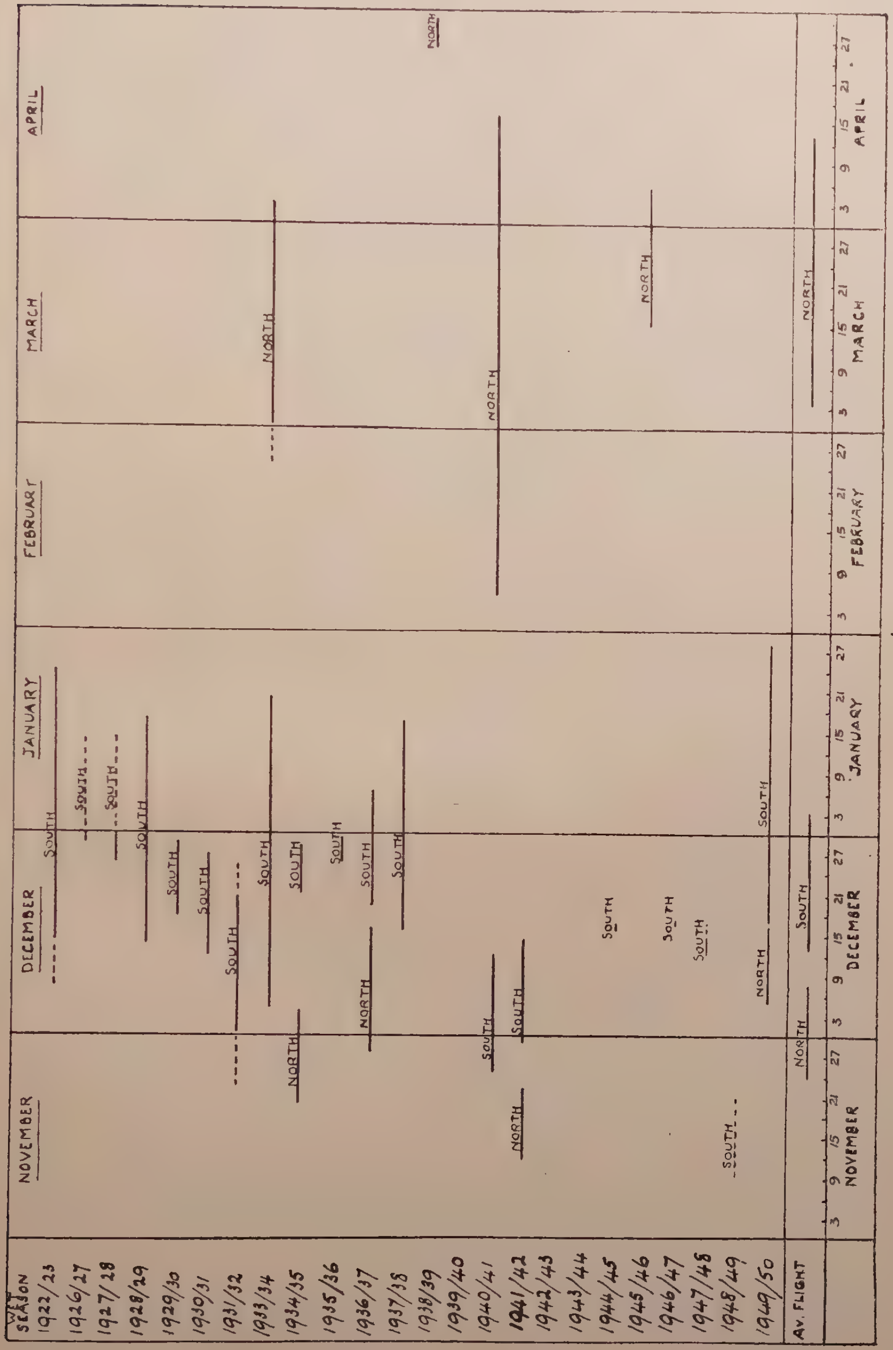

Fig. 1.—Flights of *Catopsilia florella* in northerly and southerly directions in Southern Rhodesia, 1922–1950.

some years to the end of January, but does not take place from February to November.

(b) *The Late Wet Season Flight to the North.*

The only flight records of this species for February, March and April are those showing movement to the north-east and north (figs. 1 and 3). In two years, 1934 and 1941, the northerly flights succeeded the main southerly flight after an interval of at least one month. The northerly flights in 1939 and 1945 were not preceded by a recorded southerly flight. There is no record of this flight for the months May to October.

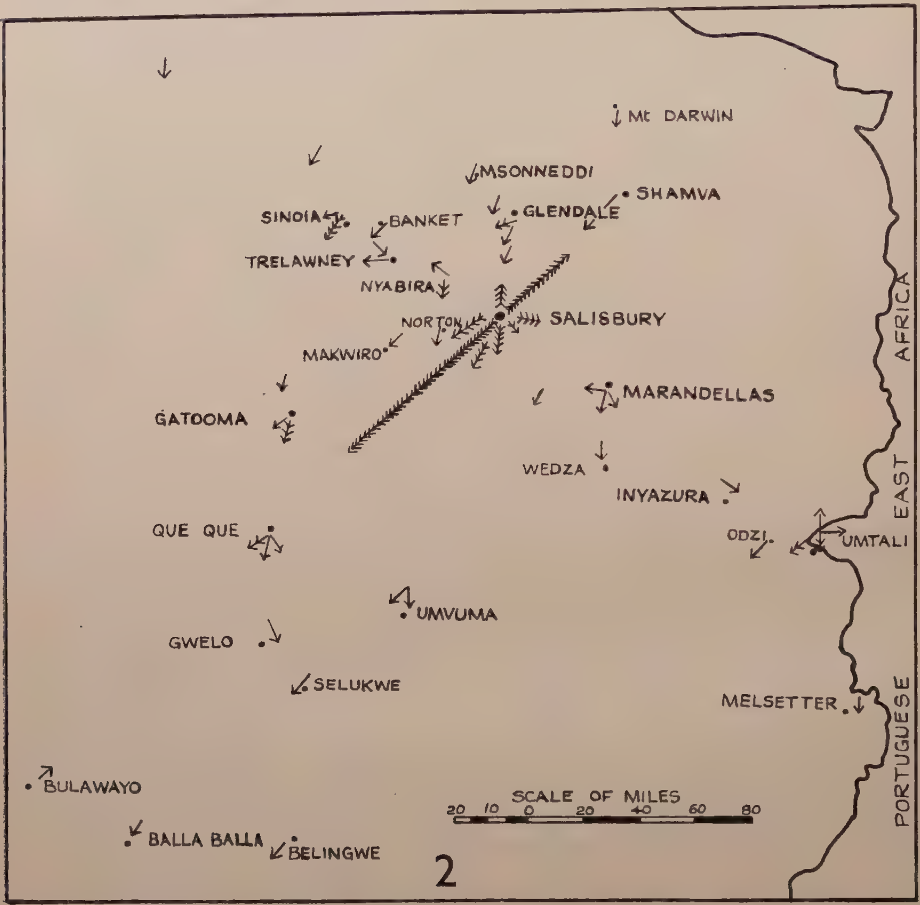

Fig. 2.—Map of Central and N.E. portions of Southern Rhodesia showing localities and directions of observed flights of *C. florella*.

The occurrence of a flight in the reverse direction from the main flight has been established for several species of migrant butterflies, e.g., *Danaus plexippus* in N. America, *Vanessa cardui* and *Pieris brassicae* in Europe, *Catopsilia* spp. in Java and *Urania* spp. in Mexico (Williams, 1930 : 322–324). Evidence is

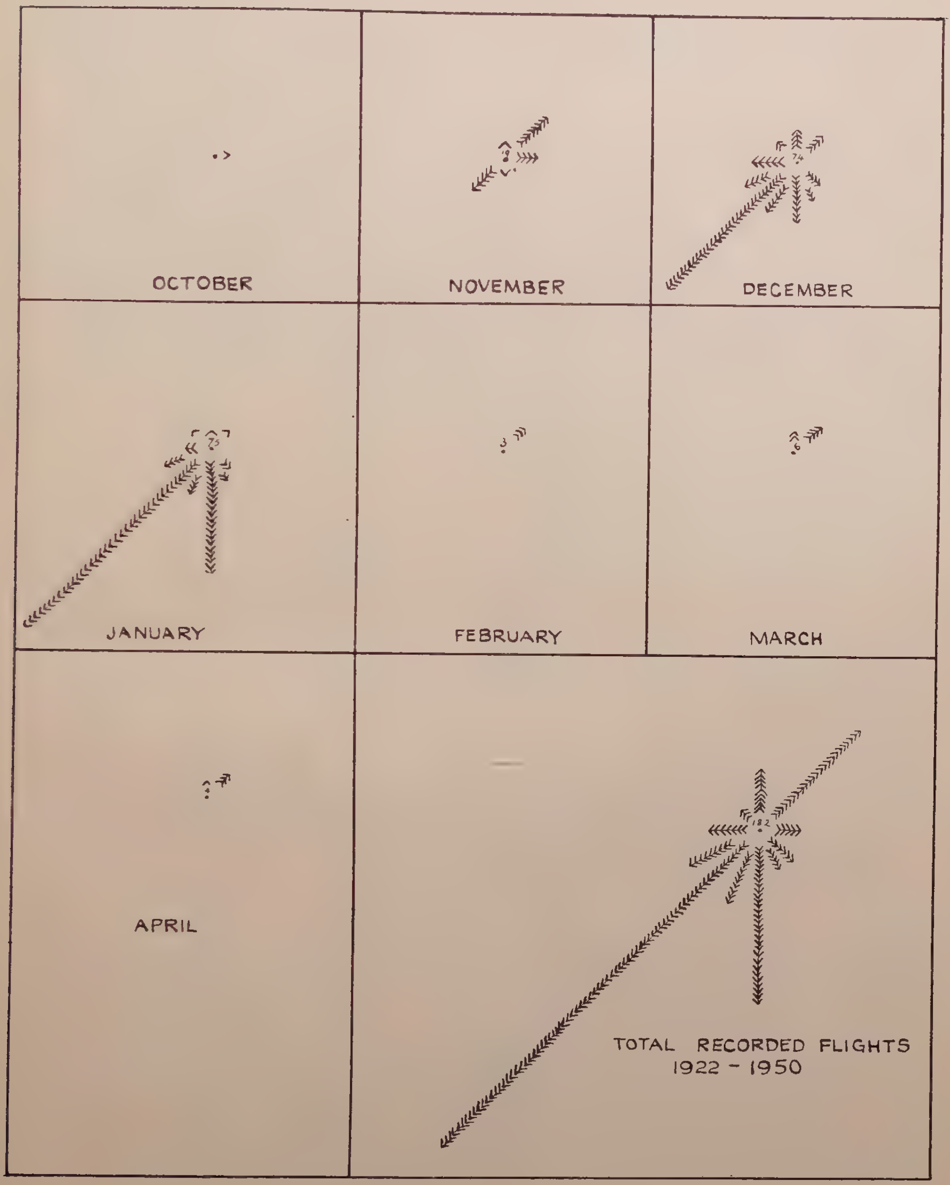

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Fig. 3.—Directional flights of *C. florella* in Southern Rhodesia arranged according to month.

accumulating to support the view that this species in Central Africa may also undergo a return movement several weeks after the passage of the main flight to the south. The nature of this return flight resembles that of the species mentioned above. The butterflies fly back in small groups and, unless specially looked for, are likely to be missed. The flights are sometimes described as a "straggling back."

(c) *The Early Wet Season Flight to the North.*

In the years 1934, 1936, 1941 and 1949 definite flights to the north and north-east were recorded during November and early December. These flights preceded the main flight to the south with only a short interval. Indeed, in December, 1949, a thin flight to the north-east was recorded until 17th December, when the first south-moving butterflies were seen. In no case was the interval between this northerly flight and the main flight long enough for a further generation to intervene. Moreover, in December, 1949, the few female butterflies caught in flight and examined showed from their immature ovaries that they would not have produced viable eggs for several weeks. It is likely that the same generation of butterflies, if not the same individuals, were involved in this change of direction. If, on the other hand, this flight to the north indicates a remnant of the flight of the previous March or April, the migrants or their progeny are capable of survival for at least six rainless months, and of preserving intact the urge to move to the north-east. Specimens caught and examined were indistinguishable from those taking part in the main flight.

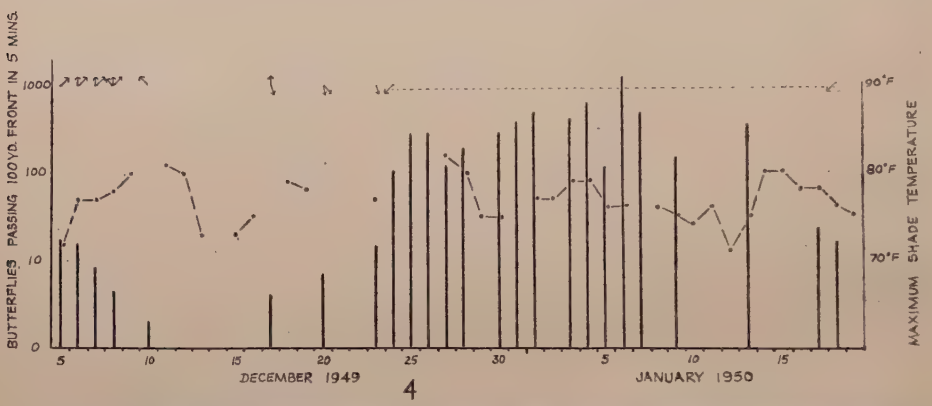

Fig. 4.—Numbers of *C. florella* passing 100 yards' front in two minutes on various days in December, 1949, and January, 1950. Absence of vertical line is due to absence of observations, not absence of butterflies.

3. The Migration of *C. florella* 1949–50.

The migration of *C. florella* which occurred from December, 1949, to January, 1950, has received special comment, since continuous observations were made by the writer. The first evidence of movement was noted on 5th December. No *C. florella* were noted prior to that date. The observations were made over experimental farm plots 80 yards × 40 yards each, extending over an area of

Table I.—*Observations on* C. florella *at Salisbury, S. Rhodesia, Dec.,* 1949–*Jan.,* 1950.

Date.	Time.	Duration (min.).	Flight.		Number per 100-yd. front per 5 mins.		Group density.
			N.	S.	N.	S.	
Dec. 5	9.10	5	19	.	16	.	2
,, 6	10.00	5	18	.	15	.	2
,, 7	9.10	5	14	.	12	.	2
	9.15	5	6	.	5	.	1
,, 8	9.42	5	5	.	4	.	1
	9.56	5	6	.	5	.	1
,, 10	9.40	5	1	.	1	.	1
	9.50	5	1	.	1	.	1
,, 17	9.35	5	1	2	1	2	1
,, 20	10.15	5	.	6	.	5	1
	10.25	5	.	10	.	8	1
,, 23	9.5	5	.	17	.	14	2
,, 24	13.30	2	.	24	.	100	3
,, 25	10.30	1	.	17	.	68	3
	11.30	1	.	97	.	485	4
,, 26	11.10	1	.	56	.	280	4
,, 27	9.20	1	.	9	.	45	2
	12.25	1	.	37	.	185	3
,, 28	—	1	.	46	.	192	3
,, 30	8.40	1	.	52	.	650	4
	8.45	1	.	39	.	195	3
		1	.	40	.	200	3
		1	.	35	.	175	3
		1	.	33	.	165	3
		1	.	81	.	405	4
		1	.	47	.	235	4
		1	.	49	.	245	4
,, 31	14.30	1	.	74	.	370	4
Jan. 1	10.00	1	.	93	.	465	4
,, 3	9.50	1	.	8	.	100	3
	10.15	1	.	56	.	700	4
,, 4	14.15	1	.	94	.	588	4
,, 5	15.30	1	.	9	.	113	3
,, 6	10.30	1	.	97	.	1213	5
,, 7	10.35	1	.	107	.	669	4
	14.30	1	.	23	.	115	3
	15.55	1	.	119	.	595	4
,, 9	9.15	1	.	9	.	114	3
	10.10	1	.	29	.	180	3
,, 13	12.25	1	.	27	.	338	4
,, 17	12.10	2	.	7	.	22	2
,, 18	11.30	5	.	12	.	15	2
Total		96	71	1461	60	9251	

The column " Group Density " indicates the intensity of the flights on the logarithmic scale devised by Williams (Williams *et al.*, 1942 : 261). This scale affords a numerical index to descriptive accounts of flight intensities, or, alternatively, translates numbers observed into a comparative account. Thus, Density 1 indicates an " extremely thin " flight, 1–2, 2 insects per 100 yards per minute, only noticeable by careful watch by an expert, while Density 5 indicates a " thick " flight of 216–1000 insects per 100-yard front per minute, which is obvious to the general public.

approximately 100 acres. By means of a stop-watch the ground speed of the butterflies was estimated at approx. 10½ to 11 m.p.h. with no wind blowing. Compass directions were determined by means of a prismatic field compass.

The numbers of individuals and directions of flight given in the list of records are summarized in fig. 4. The migration was observed at various places in or near Salisbury, for varying periods, and over different lengths of front. All observations have been reduced to numbers seen passing 100 yard front in five minutes (Table I). Fig. 4 shows the intensity of the flight from the first to last observation, with the numbers expressed as logarithms. In order to include observations when no insects were seen the numbers are expressed as N + 1. The initial movement to the N.E. decreased from 5th December until 10th December, after which no butterflies were seen until 17th December (Table I). On that day thin movements to the N.E. and to the S.S.E. were evident. On 20th and 23rd December flights were seen to the S.E. and S.S.E., but by 24th December the direction had resolved itself to true S.W., and was maintained day after day until 19th January, 1950.

The flight appeared to be most intense on 6th January, when, during periods of sunshine, the air was thick with butterflies. The butterflies reacted very quickly to changes in light intensity. If a dark cloud passed over the sun, they would immediately settle in trees and ground vegetation. As soon as the sun reappeared they would pour out from cover to continue their flight. Several species were involved in this flight, including *Phalantha phalantha* Drury, *Precis oenone* L. f. *cebrene* Trim., *Pinacopteryx eriphia* Godt., *Colias electo* L. and *Glycestha aurota* Fabricius.

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BOOK NOTICE.

Traité de Zoologie : anatomie, systématique, biologie. Ed. by P.-P. GRASSÉ. Tome X : insectes supérieures et hémiptéroïdes. Fascicules 1 and 2. 8vo. Paris (Masson et Cie), 1951. Pp. 1948, 1648 figs. Price 6500 francs per fascicule.

Tome X is divided into two fascicules as follows :

Fasc. 1. Névroptéroïdes-Mécoptéroïdes ; Hyménoptéroïdes (Symphytes et Térébrants).

Fasc. 2. Hyménoptéroïdes (Aculeates) ; Psocoptéroïdes ; Hémiptéroïdes Thysanoptéroïdes.

It follows the general pattern of the series, each Order being dealt with by the appropriate specialist from the list printed at the beginning of each volume. A general introduction to the Order includes a brief account of its phylogeny ; a detailed account of morphology, internal and external, illustrated by many original figures as well as by reproductions from standard works ; and an account at similar length of larval anatomy. Behaviour, breeding habits and biology are reviewed in detail for the Order, and geographical distribution is summarised, followed by a general account by families. There are one or two coloured plates.

DIURNAL VARIATION IN THE AERIAL DENSITY OF APHIDIDAE.

By V. F. Eastop.

(*Department of Entomology, Rothamsted Experimental Station, Harpenden, Herts.*)

During the early summer of 1949 two 9-in. suction traps, of the type described by Johnson (1950*a*) segregating their catch into hourly samples, were used to study the flight periodicity of bean and potato aphids in relation to meteorological conditions. A number of other species were caught in numbers too small for analysis with weather, but in numbers sufficient to show the general rhythm of aphid flight. Some data are also available from trapping in 1947 and 1948.

This paper considers the catch of the species other than *Aphis fabae*, which will be dealt with elsewhere in relation to meteorological factors.

Location of the Traps and Dates of Trapping.

One of the suction traps, trap " A," was placed with the mouth level with the top of the crop in the middle of a plot of beans growing in a walled garden at Rothamsted Lodge. The other, trap " B," was placed with its mouth 3 ft. 6 in. above ground level over a small potato field surrounded by allotments. Trap " B " ran from 25th June to 21st July and 23rd to 28th July. Trap " A " ran for the 24 hours of the following dates: 23rd, 25th, 27th and 29th June, 1st–3rd, 6th–9th, 11th and 12th, 14th–28th July. During this time more than three thousand aphids other than *Aphis fabae* were trapped belonging to about ninety species; of these the more abundant species, namely all those with more than forty individuals, are considered here, and also two less abundant but economically important aphids, *Macrosiphum euphorbiae* (Thos.) and *Nasonovia ribis-nigri* (Mosley). The data for these are given in Table I.

In 1947 a suction trap operated over a pasture near the meteorological enclosure at Rothamsted and the seasonal periodicity of the aphids caught in it has already been described (Johnson and Eastop, 1951). This trap was emptied by hand at intervals which varied during the summer.

In 1948 a suction trap was run in the same position as trap " A " in 1949 from 28th June to 13th August.

Results.

Table I shows that more than 97 per cent. of the aphids caught occurred between 6 a.m. and 10 p.m. G.M.T., that is to say more or less in daylight hours, and that the highest densities of all species occurred between 9 a.m. and 8 p.m. G.M.T. (fig. 1). Within this period several species had a double peak of abundance, that is, two periods of high catch separated by a period with small catches. With *Hyperomyzus lactucae* slightly greater densities occurred in the first peak than in the second peak, but with most species the second peak was the larger, both in greatest density recorded and total numbers caught, the

TABLE I.—*Total Aphids, Trap " A " and Trap " B," 23rd June–28th July,* 1949.

	Time in G.M.T.											
	00	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	10	11
Dactynotus jaceae (L.)	.	.	.	.	1	1	5	10	10	**14**	11	8
Macrosiphum euphorbiae (Thos.)	.	.	.	.	.	1	2	2	3	6	.	2
,, *rosae* (L.)	.	.	.	.	.	.	1	2	2	3	2	.
,, (*S.*) *avenae* (Fabr.)	.	.	.	.	.	.	.	4	3	3	2	.
Acyrthosiphon pisum (Harris)	.	.	.	.	1	.	1	2	2	3	2	2
Nasonovia ribis-nigri (Mosley)	1	.	.	.	.	.	.	1	2	4	2	2
Myzus persicae (Sulzer)	.	.	1	1	.	1	3	2	4	6	4	3
Hyperomyzus lactucae (L.)	.	1	1	.	.	1	5	9	16	29	24	22
Brachycaudus helichrysi (Kalt.)	.	.	.	.	.	.	.	.	.	.	6	1
,, *rumexicolens* (Patch)	.	.	.	1	.	.	.	.	1	6	.	2
Hyadaphis foeniculi (Passerini)	1	.	.	.	.	.	.	1	1	2	.	3
Cavariella aegopodii (Scopoli)	1	.	.	2	1	3	2	12	13	11	14	23
,, *theobaldi* (Gill & Bragg)	.	.	1	1	.	.	.	.	.	4	.	.
Hyalopterus pruni (Geoffr.)	1	.	.	.	2	4	11	12	**28**	**28**	24	18
Hayhurstia atriplicis (L.)	.	.	.	.	.	.	1	1	4	2	6	3
Myzocallis annulata (Hartig)	1	3	1	2	2	.	8	5	5	5	10	6
,, *castanicola* Baker	.	.	.	.	.	.	2	3	2	1	2	4
,, *coryli* (Goetze)	3	5	.	3	.	1	4	13	16	17	17	9
Eucallipterus tiliae (L.)	.	.	.	1	.	.	2	3	3	8	7	3
Anoecia corni (Fabr.)	.	.	.	.	.	.	1	.	1	3	.	5
Eriosoma ulmi (L.)	.	.	1	.	.	4	2	4	4	11	6	16
Total	8	9	5	11	7	16	50	86	120	**166**	139	132

	Time in G.M.T.												
	12	13	14	15	16	17	18	19	20	21	22	23	Total
Dactynotus jaceae (L.)	5	11	10	12	**39**	35	37	27	9	1	2	.	248
Macrosiphum euphorbiae (Thos.)	2	2	1	1	7	.	6	.	.	1	.	.	36
,, *rosae* (L.)	1	3	3	6	5	19	**23**	11	5	.	.	.	86
,, (*S.*) *avenae* (Fabr.)	2	1	4	2	4	3	3	7	2	1	.	.	41
Acyrthosiphon pisum (Harris)	1	1	4	4	**8**	3	5	2	.	.	.	.	41
Nasonovia ribis-nigri (Mosley)	.	3	1	2	4	1	2	1	.	1	1	.	28
Myzus persicae (Sulzer)	7	6	7	7	**10**	7	5	5	.	.	1	1	81
Hyperomyzus lactucae (L.)	6	16	**23**	14	17	17	17	6	3	.	.	.	227
Brachycaudus helichrysi (Kalt.)	4	5	4	**11**	8	6	9	4	2	.	.	.	60
,, *rumexicolens* (Patch)	4	2	7	**11**	7	3	2	4	.	.	.	.	50
Hyadaphis foeniculi (Passerini)	4	9	6	3	14	4	3	1	2	.	.	.	54
Cavariella aegopodii (Scopoli)	14	20	13	40	67	**92**	66	34	12	.	.	.	440
,, *theobaldi* (Gill & Bragg)	2	2	3	.	4	5	**10**	3	6	2	.	1	44
Hyalopterus pruni (Geoffr.)	21	16	55	**94**	91	31	57	68	20	2	1	1	585
Hayhurstia atriplicis (L.)	2	3	4	3	1	8	2	1	.	.	.	.	41
Myzocallis annulata (Hartig)	12	4	8	7	14	4	6	7	3	3	4	1	121
,, *castanicola* Baker	2	1	10	15	13	5	16	4	1	1	1	1	84
,, *coryli* (Goetze)	17	19	33	41	38	**44**	31	28	10	2	2	6	359
Eucallipterus tiliae (L.)	9	5	7	16	4	12	4	3	1	.	2	.	90
Anoecia corni (Fabr.)	6	6	3	6	5	5	2	.	.	.	.	.	43
Eriosoma ulmi (L.)	8	10	16	27	**32**	24	31	14	6	1	1	1	219
Tota	129	145	222	322	**392**	328	337	230	82	15	15	12	2978

Catch of hours of greatest abundance in heavy type.

latter depending on the duration of the peak and the aerial densities attained. *Dactynotus jaceae*, *Macrosiphum euphorbiae*, *M. rosae* and *Hyalopterus pruni* were examples of species with large second peak. The graphs of other species, such as *Cavariella aegopodii*, *Eriosoma ulmi* and *Myzocallis coryli*, did not show such a well-marked double peak, although its presence was suggested by a break of slope about midday ; moreover on any one day these species usually showed a more definite double peak than shown in the total in Table I, due to variation in the time of the first peak. This may also be the interpretation for species which did not show a double peak, and of which numbers trapped on any one day were too small for analysis.

Some species apparently flew in the afternoon only or in very limited numbers in the morning, e.g., *Brachycaudus helichrysi* with 10 per cent. before 11 a.m. and 42 per cent. between 3 and 6 p.m., *B. rumexicolens* with 16 per cent. before 11 a.m. and 50 per cent. between 2 and 5 p.m., compared with *Hyperomyzus lactucae* with 37 per cent. before 11 a.m. and 19 per cent. during the

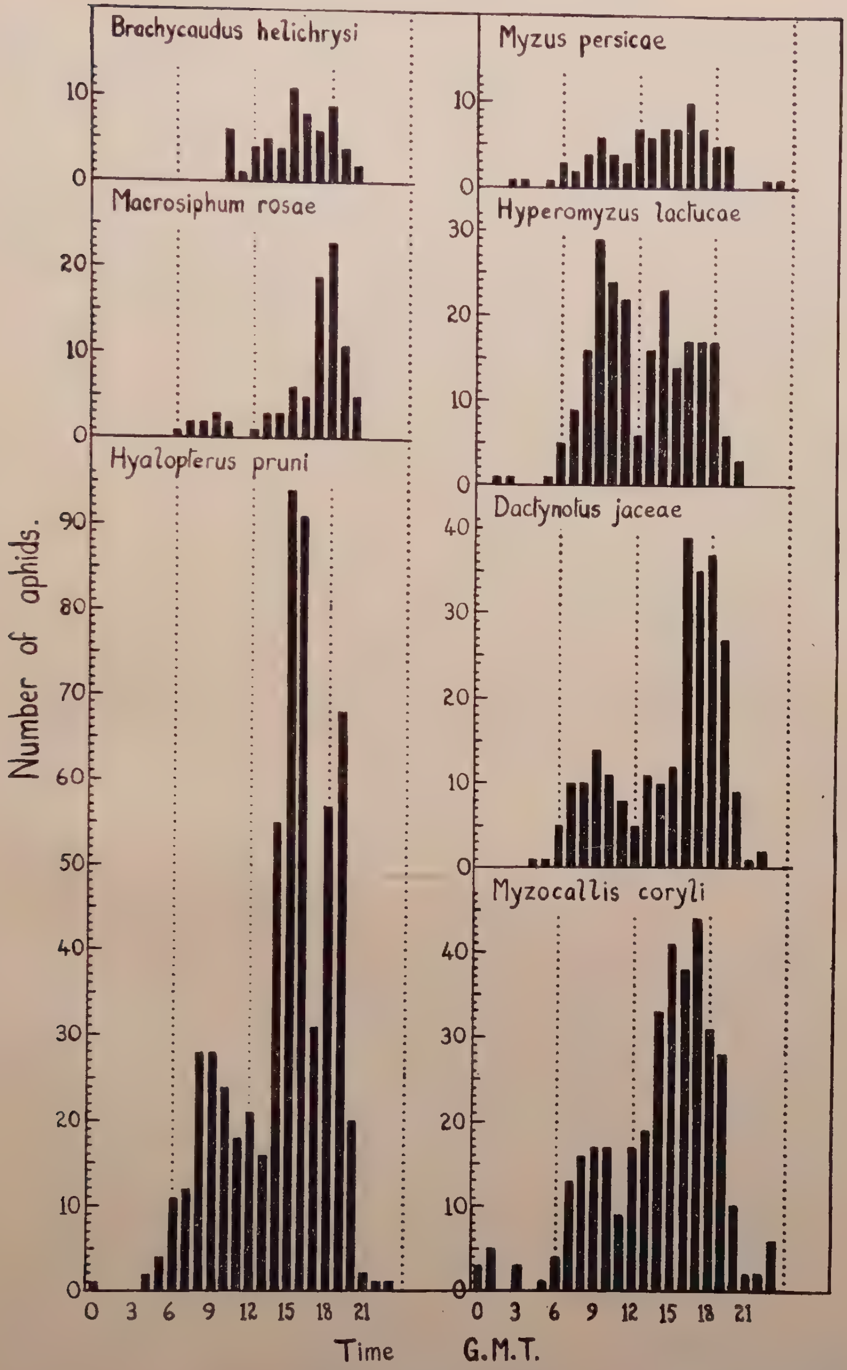

FIG. 1.—Combined hourly catch of seven species of aphids for traps A and B between 23rd July and 28th August.

three hours of greatest density during the afternoon, and *Nasonovia ribis-nigri* with 43 per cent. before 11 a.m. and 26 per cent. from 2 to 5 p.m. With *Myzocallis annulata*, *M. coryli* and *Myzus persicae* a higher proportion of the catch occurred during the hours of dusk and darkness (Table II).

TABLE II.—*Trap "A" and Trap "B,"* 1949.

	Percentage of total catch occurring between 23.00 and 07.00 hrs. G.M.T.	3-hour periods containing the greatest proportion of the catch. G.M.T.	Percentage of total catch in 3-hr. periods of greatest density.
Dactynotus jaceae (L.)	2	16–19	44
Macrosiphum euphorbiae (Thos.)	3	16–19	36
,, *rosae* (L.)	0	17–20	62
,, (*S.*) *avenae* (Fabr.)	0	16–19	32
Acyrthosiphum pisum (Harris)	2	16–19	39
Nasonovia ribis-nigri (Mosley)	7	08–11	22
,, ,, ,,	.	17–20	26
Myzus persicae (Sulzer)	6	15–18	30
Hyperomyzus lactucae (L.)	1	09–12	33
,, ,,	.	14–17	24
Brachycaudus helichrysi (Kalt.)	0	15–18	42
,, *rumexicolens* (Patch)	2	14–17	50
Hyadaphis foeniculi (Pass.)	2	14–17	43
Cavariella aegopodii (Scop.)	2	16–19	51
,, *theobaldi* Gill & Bragg	7	16–19	43
Hyalopterus pruni (Geoffr.)	2	14–17	41
Hayhurstia atriplicis (L.)	0	08–11	29
,, ,,	.	15–18	29
Myzocallis annulata (Hartig)	12	10–13	23
,, ,,	.	14–17	24
,, *castanicola* Baker	2	14–17	45
,, *coryli* (Goetze)	6	15–18	34
Eucallipterus tiliae (L.)	3	15–18	35
Anoecia corni (Fabr.)	0	11–14	40
,, ,,	.	15–18	37
Eriosoma ulmi (L.)	3	16–19	40

The data from 1947 were not suitable for this type of analysis owing to the irregular times of emptying the trap. There are, however, 5 days when the data can be used, and 5 common species, 4 of which occurred only in small numbers in 1949, are considered for this period (Table III). Other species caught conformed to the general pattern already described, and *Hyperomyzus lactucae* again had the largest densities in the first half of the day.

TABLE III.—*Results for* 1947 (12–16*th July*) *Expressed as Average Number of Aphids per Hour for the Trapping Periods.*

	G.M.T.				
	07.15–10.15.	10.15–16.15.	16.15–19.15.	19.15–07.15.	Total catch.
Metopolophium dirhodum (Walker)	6·3	13·0	14·3	1·3	165
Myzus persicae (Sulzer)	2·0	1·0	1·3	4·3	70
Hyperomyzus lactucae (L.)	0·3	4·0	1·0	0·2	30
Rhopalosiphum insertum (Walker)	5·3	6·7	9·3	0·9	94
,, *padi* (L.)	0·7	3·3	3·0	1·4	48

Drepanosiphum platanoides (Schrank) also occured in large numbers in 1947, and between 24th June and 21st August 91 were trapped, 23 per cent. occurring between 7 p.m. and 7 a.m., which was a greater proportion than that of any other abundant species, except *Myzus persicae*, which had 47·2 per cent. of its catch during 1947 between 7 p.m. and 7 a.m. There was some indication that *Myzus persicae* was flying early in the morning, as on the two days of large *Myzus persicae* migration in 1947, the 15th and 16th July, the second largest catch was the 07·15–10·15 period. The figures for *Myzus persicae* in 1947 were :

Date.	Hour.	No.
23rd June–14th July		None
14–15th July	19.15–07.15	17
	07.15–10.15	6
	10.15–13.30	2
	13.30–16.30	0
	16.30–19.30	0
15–16th July	19.30–07.15	30
	07.15–10.30	8
	10.30–16.15	11
	16.15–19.15	6

A similar occurrence was noted by Broadbent (1947) for total aphids caught in a light trap on some nights in 1933.

In the 1948 suction trap, run in the same position as trap " A " in 1949, *Hyalopterus pruni* was the only species caught in large numbers. The maximum catch for one hour was 24 per cent. of the day's total at 1600 G.M.T., and the next largest catch was 20 per cent. at 1700 hrs. The comparable figures for 1949 were : largest catch, 16 per cent. at 1500 hrs., second largest catch 16 per cent. at 1600 hrs. In 1948 *Phorodon humuli* was represented by 21 specimens ; 19 of these occurred between 2 and 9 p.m.

THE DOUBLE PEAK.

The double peak may be either a single flight activity curve, the break in it being caused by environmental factors, such as increased wind speed which inhibits flight, or as two separate activity curves ; there is some evidence that there are two peaks of production of alatae by moulting during the day. There is no doubt that the rise in density during the morning is due to the insects leaving their host plants, and, as large numbers are caught during the day at considerable altitudes (Johnson, 1949) and are not caught at night in appreciable numbers, some part of the afternoon peak must consist of insects settling out from the upper air. Particularly noticeable are early morning catches of *Myzocallis* spp., which may be due to these insects settling more slowly out of the upper air. The relatively high night catches of *Myzocallis annulata*, *M. coryli*, *Drepanosiphum platanoides* and *Myzus persicae* occurred only when these species were present in very large numbers ; at other times these species behaved normally.

CONCLUSIONS.

The greatest aerial densities of all the common species of aphids occurred between 9 a.m. and 9 p.m. G.M.T. Most species show a double peak of abundance each day with the largest peak in the afternoon. Some species occurred almost entirely in the afternoon, and there is an indication that at certain times of the year some may fly during the early morning in large numbers. These figures apply only to the biological forms and weather conditions prevalent in midsummer.

I must express my gratitude to Dr. C. G. Johnson both for making the material available and for his help and advice during the course of the work.

SUMMARY.

During the summers of 1947, 1948 and 1949 suction traps were operated continuously at Rothamsted to study the flight periodicity of bean and potato aphids in relation to meteorological conditions. Many other aphids were caught, and the diurnal variation of the aerial density of the 22 most abundant species is considered here. It was found that the greatest aerial densities of all these species occurred between 09.00 and 21.00 hrs. G.M.T., and that most species showed a double peak of abundance each day. Large night or early morning catches were observed only when a species was present in unusually large numbers.

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BOOK NOTICE.

Collecting and Breeding Butterflies and Moths. By BRIAN WORTHINGTON STUART. (Wayside and Woodland Series.) Sm. 8vo. London (Warne), 1951. Pp. 190, 1 col. pl., 17 figs. Price 10*s*. 6*d*.

The text is divided into four sections, dealing with the collecting respectively of the Perfect Insect ; the Egg Stage ; the Caterpillar Stage ; and the Chrysalis Stage. The beginner is instructed how to choose a net—and if necessary how to make one—how to use it effectively, and how to kill and store his captures. The collector is recommended to paper his specimens in the field, and is told how to relax, pin, set, store and label them afterwards.

Breeding-cages are dealt with at some length, and detailed instructions are given for sugaring and light-trapping. Caterpillar hunting and rearing, sleeving, hibernating and " frosting " are all dealt with in an intensely practical manner. The keeping of a Collector's Log Book, and the maintenance of the permanent collection are also dealt with.

THE WINGS OF *FORFICULA AURICULARIA* LINN. (DERMAPTERA).

By H. Henson, D.Sc., Ph.D., F.R.E.S.
(*Lecturer in Zoology, University of Leeds*).

I. Introduction.

Although the wings of earwigs have long been subjects of much interest to naturalists, it was not until 1911 that an attempt was made to use them for taxonomic purposes. This was in part of a paper by Zacher (1911), a work which was primarily concerned with genitalia, and which loses much of its value, in respect of wings, by the absence of figures. Further contributions by Burr (1914), Pantel (1917) and Comstock (1918) seem to represent the limit of our knowledge of this subject and, it must be confessed, give little encouragement to the hope that the wings of Dermaptera may be of taxonomic significance. Nevertheless, only further detailed study can definitely settle this matter.

As already explained (Henson, 1950), it is also hoped to provide a basis for the study of the development of external form in the common earwig, *Forficula auricularia*.

II. The General Form of the Wings.

The wings of the Dermaptera are highly distinctive of the group and are greatly modified from the normal insect type. The anterior wings are reduced to wing covers or tegmina (fig. 1a, TM), whilst in the case of the hind wing the reduction of the anterior part leaves the flying membrane to be formed entirely from the expanded anal area.

None of the various theoretical generalized forms of the insect wing which have been suggested give a complete analysis of the wing structure in *Forficula*. That put forward by Snodgrass (1935) gives a good basis for the interpretation of the basal sclerites and the veins associated with them, but is inadequate in regard to the anal area. Snodgrass, whose figure is reproduced here (fig. 1b), divides the wing into a basal or axillary region containing the axillary sclerites and an alary region containing the veins. The alary region is itself divided by the vannal fold (VF) into an anterior remigium and a posterior vannus. A membranous lobe at the base of the wing constitutes the jugum, separated from the vannus by the jugal fold (JF). The remigium contains the more usually recognized wing veins, i.e., the costa, subcosta, radius, media, cubitus, and post-cubitus. This latter is said by Snodgrass to correspond to the first anal vein of the Comstock-Needham system. The vannus contains a number of vannal veins (VV) and the jugum one or two jugal veins (JV).

On the anterior margin of the wing, near its attachment to the body, is a fleshy hairy lobe, the *tegula* (fig. 1b, TG). Immediately distal to this is a small sclerite, the *humeral plate* (HP), which subtends the costal vein (CO) along the

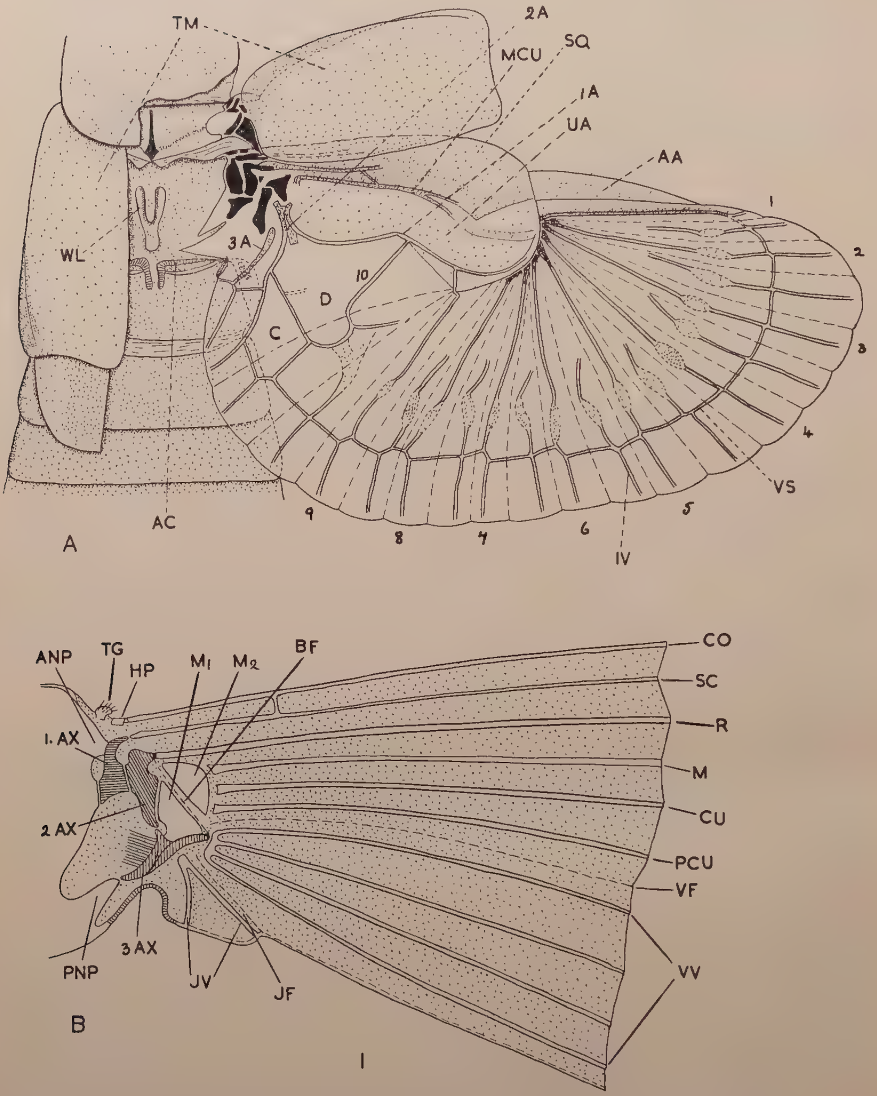

Fig. 1.—A, Wings and thorax of *F. auricularia*; B, generalized insect wing (from Snodgrass, 1935). 1A, 2A, 3A, first, second and third anal veins; 1Ax, 2Ax, 3Ax, first, second and third axillary sclerites; 1–10, first to tenth radiating veins; AA, apical area; AC, axillary cord; ANP, anterior notal process; BF, basal fold; C, enclosed area at base of wing; CO, costa; CU, cubitus; D, enclosed area at base of wings; HP, humeral plate; IV, intercalary vein; JF, jugal fold; JV, jugal vein; M, media; M_1, M_2, median sclerites; MCU, medio-cubitus; PCU, postcubitus; PNP, posterior notal process; R, radius; Sc, sub-costa; SQ, squama; TG, tegula; TM, tegmen; UA, ulnar area; VF, vannal fold; VS, transverse vein; VV, vannal veins; WL, wing-locking device.

anterior wing margin. The *first axillary* (1Ax) forms the anterior hinge plate of the wing base. It articulates anteriorly with the anterior notal process of the tergum (ANP), and posteriorly with the tergal margin. The anterior end of the sclerite is produced forwards as a process which is always associated with the subcostal vein (SC). The second axillary (2Ax) is obliquely hinged to the outer margin of the first and its anterior end is flexibly articulated to the radius (R). The third axillary (3Ax) articulates between the second axillary and the posterior wing process of the tergum (PNP); distally it is associated with the whole group of vannal veins. The median plates (M_1, M_2) are not so specifically differentiated as are the axillaries; the more distal plate (M_2) is associated with wing veins media (M), cubitus (Cu) and postcubitus (PCu). Between the two median plates is the basal fold (BF), along which the remigium will fold on the axillary region.

III. The Hind Wing.

In the hind wing of *Forficula* the reduction of the remigium has resulted in the reduction of all the main veins of the wing, whilst the expansion of the vannus implies that most of the visible veins are vannal veins (figs. 1A, 2B). As will be seen later there are difficulties in the way of applying Snodgrass's conception of the vannus to *Forficula*, and it is preferable, for the present, to use the older terms of anal area and anal veins.

The earlier authors divide the Dermapteran hind wing into a number of areas. Burr (1914), following Zacher (1911), recognizes a marginal area (not identifiable in *Forficula*), a squama, an apical area, an ulnar area, and an anal area. The marginal area is a small lobe without veins at the base of the costal margin. The squama (fig. 1A, SQ) is a strongly chitinized area which protrudes from beneath the tegmen in the position of rest; it occupies the whole region between the medio-cubitus vein (MCu) and the costal margin. Beyond the squama, from which it is separated by a well-marked hinge, is the lanceolate apical area (AA), which is rather strongly chitinized but contains no veins. The ulnar area (UA) is a clear veinless field between the medio-cubitus vein (MCu) and the first anal vein (1A) (= the ulnar vein of Burr). The anal area is the membranous remaining part of the wing. It seems most probable that the squama and ulnar area represent the whole of the remigium, and that the apical area and anal area represent the vannus. The apical area has no veins, but a well-marked line of folding along its centre is in series with the radial lines of folding of the anal area. Although this is but a slender indication, there seems to be no other feature on which an opinion can be based.

On the margin of the squama close to the anterior notal process are two small plates clearly representing the tegula (TG) and humeral plate (HP) (fig. 2A). The anterior margin in this region is thus shown to be the costa. Behind the tegula is a typical first axillary (1 Ax) complete with peg-like process subtending a vein which must therefore be the subcosta (SC). Articulating with the first axillary is a large second axillary (2Ax) associated with a vein, greatly expanded basally, which is therefore to be interpreted as the radius (R). The third axillary is represented by two plates ($3AX_1$ and $3Ax_2$), the outermost of which subtends the anal veins. Above the outer third axillary are a number of median plates (MP), the most distal of which subtends a vein which is often double at its base as well as distally. This may be identified as the fused media and cubitus (MCu). The postcubitus has not been recognized.

The variations which occur in the venation of the squama are numerous, and often not confined to trivialities. The subcosta may be well marked, represented only by a small basal sclerotized area, or entirely absent. The medio-cubitus is much less often separable into two veins basally than distally—nevertheless this still constitutes an important piece of evidence in its interpretation as a medio-cubitus (*v.* figs. 1A, 2A, 2B). A cross vein is usually, but not always, to be seen between the radius and medio-cubitus ; in some cases as many as four of these veins may be present (fig. 2A). The presence of cross veins also supports the view that this vein is a medio-cubitus, since such cross veins could not pass directly from the radius to the cubitus. Of the basal sclerites the tegula, the humeral plate and the first and second axillaries are constant and have been seen in all specimens examined. The third axillary is often broken up into a whole series of small separate sclerites, as in Pantel's figure (1917), and is then not easily recognized. The inner median plate is frequently small or absent, and even when present is often weakly sclerotized and difficult to see.

In marked contrast to the reduction of the main wing veins is the enlargement and profusion of the anal veins. The third axillary is associated with three main veins, all of which are greatly expanded and sclerotized at the base. Following Comstock (1918), these may be referred to as the first, second and third anal veins.

The first anal (fig. 2A, 1A) is to some extent associated basally with one of the median plates ; indicating that the post-cubitus of Snodgrass may be involved. Since this vein ultimately branches in a most profuse manner it cannot be solely postcubitus but must also correspond to at least one of the vannal veins of Snodgrass. One of the main lines of folding of the wing runs from the third axillary (fig. 2A, dotted line) behind the main trunk of the anal veins, across the wing, parallel to and behind the first anal vein, and then across the ulnar area and round the squama to the wing margin. This presumably is the vannal fold. It is not wholly typical in position but, such as it is, it lends some support to the notion that the postcubitus is involved with 1A. However, unless evidence, as opposed to mere indications, can be obtained from other types, it seems better to leave this problem as unsolved and refer to this vein simply as the first anal.

The second anal vein calls for no special comment ; it is undoubtedly one of the vannal veins, but the third anal could conceivably be a jugal vein. This interpretation is favoured by the fact that it arises from the third axillary as a separate trunk and the alary cord reaches as far as its innermost branch. On the other hand, the innermost fold of the wing, which would seem to be the jugal fold (JF, fig. 2B), is on the inner, not the outer side of the vein. It seems better therefore not to prejudge the matter but to retain the name third anal.

The first anal vein (figs. 2A, 2B) forms the lower boundary of the ulnar area, and then turns sharply upwards towards the wing margin to terminate at the base of the apical area. It gives rise to ten radiating anal veins, eight close together near its termination, and two, numbers 9 and 10, further back along its main course. Radial veins 1 to 8 are reasonably straight, but 9 and 10 pursue a more complicated course.

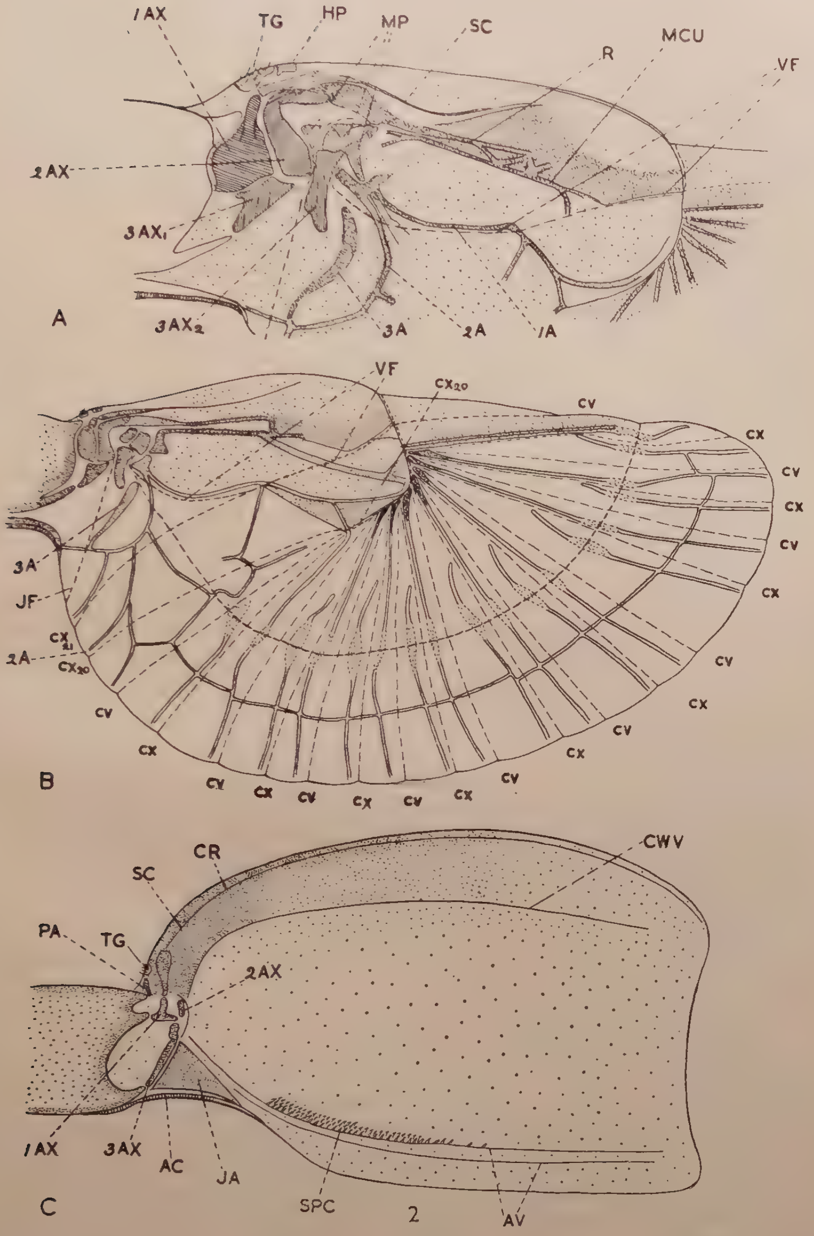

Fig. 2.—*F. auricularia.* A, remigium; B, entire hind wing; C, tegmen. 3Ax$_1$, 3Ax$_2$, parts of the divided third axillary; AV, possible anal veins; CR, costal ridge or subcostal vein; CV, concave lines of folding; CWV, possible central wing veins; CX, convex lines of folding; JA, jugal area; PA, pre-alary; SPC, spiny crest; VF, suggested course of vannal fold. Other letters as in fig. 1.

Between the radial veins is a series of intercalary veins (IV, fig. 1A) each of which extends from near the wing margin to rather more than half the length of the radial vein nearest to it. The intercalaries and the radial veins are connected by cross veins, which collectively form a long transverse vein parallel to the wing margin, the " vena spuria " of the older authors. Internally to this transverse vein the intercalaries and the first nine radial veins are broadened out and less strongly chitinized, a modification associated with the transverse folding of the wing along this line. The intercalary and the radial vein on its outer side are markedly curved towards one another, giving an impression of an associated pair, an impression that is heightened by the fact that each pair is closer together than the pairs are to each other (figs. 1A, 2B).

The ninth radial vein differs from the rest in being bent into a right angle near its origin from the main trunk of the first anal. The tenth vein also is peculiarly angled about the middle of its course, producing a loop which is functionally connected with the folding of the wing, as will be described later. Attached to the upper side of this loop are one (fig. 1A) or two (fig. 2B) incomplete branches which suggest, albeit rather vaguely, a suppressed radial vein and associated cross veins.

The second anal vein is connected to the tenth radial by two cross veins, a lower one in series with those forming the " vena spuria " and a higher longer vein whose presence creates two enclosed areas (C and D, fig. 1A) in the centre of the inner angle of the wing.

The third anal seems to be fundamentally two-branched, the outer branch connected to the second anal by a short cross vein which, as before, can also be interpreted as in series with those forming the " vena spuria." The proper interpretation of the veins of the inner angle of the wing is not possible since, as yet, it has no basis in comparative morphology. The alary cord is well developed ; it extends from the extreme inner angle of the wing margin right along the posterior margin of the metanotum, almost meeting its fellow in the mid-dorsal line (AC, figs. 1A, 2A, 2C).

On the whole the wing is almost certainly derivable from an Orthopteran type. The expanded anal area has very suggestive similarities with that of Phasmids and some Gryllids, more particularly in such details as intercalary veins, cross veins and lines of folding between the veins. Moreover, the division of the third axillary into two is foreshadowed to some extent in the form of this sclerite in certain Blattids.

Zacher (1911) seems to have been one of the first to attempt the analysis of the wing of the earwig. His nomenclature is now outmoded, and at least some of the features to which he attached taxonomic importance are variable within the single species *F. auricularia*. Burr (1914) describes in general terms the wings of a number of species, and concludes that there is no set of characters in the venation which gives a sharp division of the lower from the higher Dermaptera. Pantel (1917) gives an accurate and detailed account of the wing attachments in *Forficula*, but interpretation in the modern sense could not be expected. Comstock (1918) agrees with the present account in the interpretation of the radius, but regards the vein here designated medio-cubitus as cubitus alone, largely on grounds of the form of the tracheation in the nymphal wing.

The folding of the wing is a highly complex process, of which some idea can be gained from a study of the lines of folding as shown in fig. 2B. First of all the greater part of the anal area folds up like a fan about the radial lines CX and CV. The lines marked CX are the apex of convex folds, and those marked CV the apex of concave folds. The closed fan then doubles over on itself laterally about the weakly sclerotized areas on the course of the radiating and intercalary veins. The folded area then bends along line CX20 beneath the area between lines CX20 and CX21. In this process the apex of the folds, represented by the weakly sclerotized regions of the radiating veins, fits into the angled portion of radiating vein 10. In observing the folding of the wing the functional significance of the peculiar form of vein 10 is self evident. The whole of the vannus now tucks away under the squama about the line VF. Finally the whole wing pivots round to its normal resting position over the dorsum by folding along the line in the jugal region (JF) and along the fold passing between the second and third axillary sclerites and the median plates. The enclosed area D (fig. 1A, 2B) is large enough to wrap neatly round the end of the folded mass of the vannus before it is tucked away beneath the squama.

IV. The Fore Wing.

The fore wings or tegmina have little structural detail compared with the hind wings. Although quite clearly adapted to function as wing covers they are rather small, and do not completely cover the hind wings in repose (fig. 1A, left side). Each tegmen is composed of a main region which is almost flat and an anterior costal field reflected almost vertically downwards. The axillary sclerites, set in a supple membrane, largely conform to the general insect plan. On the underside of the wing, near its inner margin, is a spiny crest which in the position of rest locks the wing to a special grooved device on the mid-dorsal surface of the metanotum (WL, fig. 1A). On the external face of the tegmen there is a submarginal cuticular thickening known as the costal ridge (CR, fig. 2C).

On the front margin of the wing is a typical hairy tegula (TG, fig. 2C). Between this and the margin of the mesonotum is a small sclerite identified as a pre-alare, i.e., a detached piece of the notum. More posteriorly is a typical first axillary (1Ax), the anterior process of which subtends a rather strongly chitinized area continuous distally with the submarginal costal ridge. It would appear, therefore, especially after comparison with the hind wing, that sclerotized area and costal ridge are really the last vestiges of the subcostal vein (SC, fig. 2C). Distally to the first axillary is a small second axillary behind which lies a large third axillary extending back to the posterior notal process. The posterior edge of the costal field, i.e., the line along which it is deflected downwards, is often marked by a slight structural line which passes into a vaguely more sclerotized area near the second axillary. This line, together with a second, which is even less clearly defined and has been seen in two specimens only, may represent all that remains of the central wing veins (CWV, fig. 2C).

Attached to the third axillary, which is usually partially divided into two plates, is a heavily sclerotized triangular area projecting out into the wing and carrying the alary cord on its posterior border. In repose this folds beneath the main body of the tegmen, and without doubt seems to represent the jugal area (JA). Running from the upper end of the third axillary is a line, for the most part ill-defined, which passes backwards and outwards parallel to the wing margin. In its middle region this line is greatly thickened to form the spiny crest which holds the tegmen into the median metanotal wing-locking device (WL, fig. 1A). The number of spines on this crest is large, approaching a hundred; proximally they are arranged in three rows, tapering off to two and then one distally. In some specimens a second line just behind the one forming the spiny crest is to be seen. Since these two lines project from the third axillary they may represent the vestigial remains of anal veins.

V. SUMMARY.

1. The form of the wings, the basal sclerites and the wing venation are described and figured. The fore wings are reduced to tegmina; the hind wings have a much reduced remigium and an expanded vannus which alone constitutes the flying membrane.

2. Both wings are compared with the generalized type, especially the generalized orthopteran type as described by Snodgrass (1935).

3. In the hind wing the basal sclerites comprise the first, the second, and a divided third axillary. The remigium shows four principal veins which from their relations to the axillaries are resolved as being costa, sub-costa, radius and medio-cubitus. The medio-cubitus is interpreted as such because it is often forked proximally and because of the presence of the cross veins from the radius (such veins could not pass directly to a cubitus). The postcubitus has not been recognized.

4. The vannus cannot at present be interpreted in terms of the generalized type and its three main veins are referred to as first, second and third anal veins; the latter may be the jugal vein. The first has ten radiating branches, the second two and the third two. Between the radiating branches is a series of intercalary veins, whilst a long transverse vein runs parallel to the wing margin.

5. The major lines of folding of the wing are shown in fig. 2B, and the complex process of the folding of the wing is described in the text.

6. The tegmina have basal sclerites which conform closely to the generalized type. Vague lines are present which suggest vestiges of the sub-costa, two of the central wing veins and two anal veins. One of these latter has a spiny crest which locks the wing to a special grooved device on the dorsum of the metanotum. The jugal area is present as a heavily sclerotized fold.

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INDEX

ACRIDIDAE, *ability of certain spp. to change colour on burnt ground*, 45–48
Acrythosiphum, 20, 98
albidum, Metopolophium, 20
Alloeorhynchus, 1, 5, 7
Anopheles, 109–111
Anuraphis, 99
APHIDIDAE, *diurnal variation in aerial density*, 129–134 ; *method of trapping*, 129 ; *tabulated data of species caught*, 130–131 ; *analysis*, 132–133
Aphids, *captured in a suction trap in* 1947, 17–24 ; *methods, identification*, 17 ; *biological data*, 17–20 ; *additions to British list*, 20 ; *tabulated lists of species*, 22–24 ; *excretion*, 97–103
apterus, Himacerus, 3
archangelicae, Cavariella, 20
Aspilapsis, 1, 5, 7
atriplicis, Hayhurstia, 99, 101
atroparvus, Anopheles maculipennis *experimental hybridization*, 109–111
Aulacobothrus, 45–48
Aulacorthum, 98
auricularia, Forficula, *wings of*, 135–142

blunki, Eulachnus, 20
boops, Stålia, 4
Brachionycha, 80
Brachycaudus, 98
brassicae, Brevicoryne, 98, 101
Brevicoryne, 98, 101
bursaria, Byrsocrypta, 99, 102
Byrsocrypta, 99, 102

campestris, Lyctocoris, 6, 7
canescens, Nemeritis, *influences on oviposition*, 49–58
capsiformis, Nabis, 7
caraganae, Acrythosiphum, 20
cardui, Brachycaudus, 98
Catopsilia, 113–128
Cavahyalopterus, 20
Cavariella, 20
cerasi, Myzus, 98
chamomillae, Macrosiphoniella, 20
Chrotogonus, 64–66
Chrysomela, 67–73
CHRYSOMELIDAE, *protective device in pupae of*, 67–73
Cimex, 6, 7
Cossus, 80
cossus, Cossus, 80
Culicoides, 59–63
cuprea, Chrysomela, 67

Dactynotus, 98
Dilina, 77, 80, 82–86
dispar, Tanita, 65–66
Dolichonabis, 1, 4, 7, 10
dominula, Panaxia, 80

elegans, Zonocerus, 64, 66
Ephestia, 49–59
Eremogryllus, 89–92
Eriococcus, 43
Eriopeltis, 44
Eriosoma, 99, 101
Ernobius, 74–76
Eulacnus, 20
euphorbiae, Macrosiphum, 98
Eupsilia, 80
eva, Prostemma, 5

fabae, Aphis, 98
festucae, Eriopeltis, 44
feytaudi, Matsucoccus, 44
flavipes, Alloeorhynchus, 7
flavus, Phorticus, 7
florella, Catopsilia, *migration records from Southern Rhodesia*, 113–128
Forficula, 135–142
frequens, Holcaphis, 99
fulgens, Urania, *migration of, on Isthmus of Panama*, 38–39

granulatus, Periphyllus, 20
Graphosoma, 7, 8
grisella, Meliphora, 55, 57
grossulariae, Aphis, 98, 102
guttula, Prostemma 5, 7

Habrobracon, 50
hammadae, Eremogryllus, *stridulation*, 89–92
Hayhurstia, 99, 101
Himacerus, 1, 3, 4, 7
Holcaphis, 99
humilis, Polistes, *biology of, with special reference to the nature of the worker caste*, 11–16
Hyalopterus, 98, 100

impunctatus, Culicoides, *population range and flight density*, 59–63
instigator, Pimpla, 55

jaceae, Dactynotus, 98
Jacksonia, 41–42
juglandis, Habrobracon, 50

kühniella, Ephestia, 49–58

lanigerum, Eriosoma, 99, 101
lapponica, Chrysomela, 67
Lasiocampa, 80
lativentris, Himacerus, 4, 7
lectularius, Cimex, 6, 7
Lepidoptera, *aspects of morphology of insect head as seen in*, 77–88
limbatus, Dolichonabis, 1, 4, 7
lineatum, Graphosoma, 7, 8
Locusta migratoria migratorioides, *blood cell counts*, 25–36
Lyctocoris, 6, 7
LYMANTRIIDAE, *urticating properties of adults*, 104–108 ; *tabulation of species on character of anal tuft*, 106–107

machaon, Papilio, 80
Macrosiphoniella, 20, 98
Macrosiphum, 98
maculipennis, Anopheles, 109–111
Matsucoccus, 43, 44
Meliphora, 55, 57
Metopolophium, 20
migratorioides, Locusta migratoria, *blood cell counts*, 25–36
millefolii, Macrosiphoniella, 98
mollis, Ernobius, *prothetely in*, 74–76
mühlei, Cavahyalopterus, 20
Myzus, 98, 100–101

NABIDAE, *absence of symbionts in male genital organs*, 1–10
Nabis, 1–10
Nemeritis, 49–58
Nezara, 9
nymphaeae, Rhopalosiphum, 98

Ourapteryx, 80

paludinus, Pseudococcus, 43
Panaxia, 80
Papilio, 80
papillata, Jacksonia, *food-plant of*, 41–42
Periphyllus, 20, 98
persicae, Myzus, 98, 100–101
personatum, Seristocoma, *larvae of*, 93–96
Phorticus, 1, 3, 5, 7
Phyllodecta, 67
Pimpla, 55
pini, Matsucoccus, 43
pisum, Acyrthosiphon, 98
Plagiodera, 67, 69–73
Polistes, 11–16
populi, Chrysomela, 67
Prostemma, 1, 5, 7
Protrama *sp.*, 100
pruni, Hyalopterus, 98, 100
Pseudococcus, 43
PYRGOMORPHINAE, *occurrence of fully winged forms in usually brachypterous African species*, 64–66

quadrimaculatus, Anopheles, *experimental hybridization*, 109–111
quercus, Lasiocampa, 80

rendalli, Chrotogonus, 64–66
Rhopalosiphum, 98
rosae, Macrosiphum, 98

sambucaria, Ourapteryx, 80
Sericostoma, 93–96
solani, Aulacorthum, 98
speciosus, Tylotropidius, 45–48
sphinx, Brachionycha, 80
Stålia, 1, 4
subterranea, Anuraphis, 99

Tanita, 65–66
tenerum, Metopolophium, 20
testudinatus, Periphyllus, 98
tiliae, Dilina, 77, 80, 82–86
transversa, Eupsilia, 80
tremula, Chrysomela, 67–73
Tylotropidius, 45–48

ulmi, Eriosoma, 99, 101
Urania, 38–39

versicolora, Plagiodera, 67, 69–73
viridula, Nezara, 9
viridulus, Aspilaspis, 7
vitellinae, Phyllodecta, 67

wernerianus, Aulacobothrus, 45–48

Zonocerus, 64, 66

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